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APPLICATION
FOR
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LETTERS PATENT

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FOR: **FRAME TRANSFER METHOD AND
NODE IN ETHERNET**

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FRAME TRANSFER METHOD AND NODE IN ETHERNET

BACKGROUNDS OF THE INVENTION

1. Field of the Invention

5   The present invention relates to a node to relay

the Ethernet frame and a frame transfer method.

2. Description of the Related Art

Conventionally, a node in Ethernet is controlled

with a network control frame shown in Fig. 18 storing

10   the network control information 12006 in the payload

section and the address of the node to be controlled in

the MAC address (Destination MAC address 2001 and the

source MAC address 2002) and the IP address (IP address

of controlled terminal 12004).

15   Therefore, while the user uses the entire network

bandwidth for data transmission, the node cannot send

the control frame. In addition, the control frame needs

to have at least 64 bytes regardless of the control

information amount for the node according to Ethernet

20   standard specified by IEEE802.3.

IEEE802.1Q, that provides for the technology

related to the VLAN, specifies that a VLAN tag shall be

given to a frame during frame relay for network

separation.

25   Therefore, the node that relays conventional

Ethernet frames has a function to process at most one

VLAN tag at a time in frame relay and the forwarding

table to store the VLAN tag information given during such frame relay assures an information area for one VLAN tag only.

In addition, since the VLAN tag in the frame is the information for network separation, the node that relays the frame with VLAN tag does not have a function to change the contents of the VLAN tag. The information in the VLAN tag is used for frame transfer only.

Further, in transmission of the VLAN frame at the data link layer, the frame is relayed and the transfer port is determined by reference to the MAC address and the VLAN ID.

The conventional node control in Ethernet as described above has drawbacks as follows:

Firstly, the conventional node in Ethernet as specified in IEEE802.3 is controlled using the frame storing the control information in the payload section and the address of the node to be controlled in the MAC address and the IP address as shown in Fig. 18. Thus, while the user uses the entire network bandwidth for data transmission, the node cannot send the control frame.

Secondly, the control frame needs to have at least 64 bytes regardless of the control information amount for the node according to Ethernet standard. If the control frame is frequently sent in the network, it may oppress the bandwidth of the user data.

Thirdly, when the VLAN tag is given for frame transfer, several VLAN tags cannot be provided because there is no information area in the forwarding table.

Fourthly, in case a loop network is formed in IEEE802.3 Ethernet, because a function to discard frames when a loop of packet transfer is generated in VLAN packet transfer at the data link layer has not been realized, the looped packets occupy the network or induce oppression of the packet memory in the system, which results in unstable status of the network.

SUMMARY OF THE INVENTION

A first object of the present invention is to propose a frame transfer method and a node in Ethernet that enable transmission of the network control information from the node even while the user is using the network.

A second object of the present invention is to propose a frame transfer method and a node in Ethernet that can minimize oppression of the network bandwidth caused by transmission of the network control information by enabling transmission of the minimum information regardless of the frame restriction.

A third object of the present invention is to propose a frame transfer method and a node in Ethernet that can send a large information amount including the network control information as tags by enabling

provision of several tags in frame transfer.

A fourth object of the present invention is to enable discarding of frames in VLAN packet transfer at the data link layer and to thereby propose a frame transfer method and a node in Ethernet that prevent the network to be unstable by avoiding occupation of the network by looped packets and oppression of the packet memory in the system.

According to the first aspect of the invention, a node to relay the Ethernet frame comprising element which inserts two or more VLAN tags into the frame and removes the inserted VLAN tag in the relay process of the frame.

In the preferred construction, a node further comprises element which replaces two or more VLAN tags of the frame at a time.

In another preferred construction, a node further comprises element which administrates the two or more VLAN tags using the forwarding table memory for change of frame contents during frame relay.

In another preferred construction, a node further comprises element which searches the forwarding table memory using the information from two or more VLAN tags in the frame during frame relay.

In another preferred construction, a node further comprises element which searches the forwarding table memory in the relay process of the frame with combining

the information from two or more VLAN tags in the frame and the input port, the destination MAC address, the source MAC address and the TYPE field information.

In another preferred construction, a node comprises element which provides a TTL area to show the survival time of the frame in the VLAN tag inserted to the frame and checks whether the survival time has elapsed or not by the value in the TTL area and discards the frame after elapse of the survival time without relaying it in the relay process of the frame.

In another preferred construction, a node further comprises element which decrements the value in the TTL area by one every time the frame is relayed.

In another preferred construction, node control information is stored to the VLAN tag.

In another preferred construction, a node further comprises element which changes the self-node status administration corresponding to the contents of the VLAN tag.

In another preferred construction, the node status is stored to the area of the VLAN tag in the relayed frame corresponding to the self-node status.

According to another aspect of the invention, a frame transfer method of the node to relay the Ethernet frame comprising a step of inserting two or more VLAN tags to the frame at a time or removing the inserted VLAN tags in the relay process of the frame.

In the preferred construction, a forwarding table memory for frame contents change during frame relay is used for administration of the two or more VLAN tags.

In another preferred construction, a forwarding table memory is searched during frame relay using the information from two or more VLAN tags in the frame.

In another preferred construction, a forwarding table memory is searched in the relay process of the frame with combining the information from two or more VLAN tags in the frame and the input port, the destination MAC address, the source MAC address and the TYPE field information.

In another preferred construction, a TTL area to show the survival time of the frame is provided in the VLAN tag that is inserted to the frame and whether the survival time has been elapsed or not is checked by the value in the TTL area and the frame after elapse of the survival time is discarded without being relayed in the relay process of the frame.

In another preferred construction, the value in the TTL area is decremented by one every time the frame is relayed.

In another preferred construction, node control information is stored to the VLAN tag.

In another preferred construction, a frame transfer method further comprises changing the self-node status administration corresponding to the contents of

the VLAN tag.

In another preferred construction, node status is stored to the VLAN tag area in the relayed frame corresponding to the self-node status.

5   Other objects, features and advantages of the present invention will become clear from the detailed description given herebelow.

BRIEF DESCRIPTION OF THE DRAWINGS

10   The present invention will be understood more fully from the detailed description given herebelow and from the accompanying drawings of the preferred embodiment of the invention, which, however, should not be taken to be limitative to the invention, but are for

15   explanation and understanding only.

In the drawings:

Fig. 1 is a block diagram showing the configuration of a VLAN switching hub according to an embodiment of the present invention;

20   Fig. 2 is a block diagram showing the configuration of a packet forwarding unit according to an embodiment of the present invention;

Fig. 3 is a block diagram showing the configuration of a frame analyzer in the packet

25   forwarding unit;

Fig. 4 is a block diagram showing the configuration of a table search unit in the packet

forwarding unit;

Fig. 5 is a block diagram showing the configuration of a forwarding table memory in the packet forwarding unit;

5   Fig. 6 is a configuration diagram of a table memory in the forwarding table memory;

Fig. 7 is a block diagram showing the configuration of a frame rewrite unit in the packet forwarding unit;

10   Fig. 8 is a block diagram showing the configuration of a tag calculation unit in the frame rewrite unit;

Fig. 9 is a block diagram showing the configuration of a frame aggregation unit in the packet

15   forwarding unit;

Fig. 10 is a block diagram showing the configuration of a frame transfer unit in the packet forwarding unit;

Fig. 11 is a configuration diagram of a CPU in

20   the VLAN switching hub;

Fig. 12 is a diagram showing an example of network configuration;

Fig. 13 is a configuration diagram of an Ethernet frame with a standard VLAN tag;

25   Fig. 14 is a configuration diagram of a standard VLAN tag;

Fig. 15 is a configuration diagram of a tag

according to the present invention;

Fig. 16 is a configuration diagram of a network control frame according to the present invention;

Fig. 17 is a configuration diagram of a network control tag according to the present invention; and

Fig. 18 is a configuration diagram of a standard network control frame.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred embodiment of the present invention will be discussed hereinafter in detail with reference to the accompanying drawings. In the following description, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be obvious, however, to those skilled in the art that the present invention may be practiced without these specific details. In other instance, well-known structures are not shown in detail in order to unnecessary obscure the present invention.

Referring to the attached figures, embodiments of the present invention will be described in details below.

Fig. 1 is a configuration diagram of a VLAN switching hub in the node to relay the Ethernet frame as an application of the present invention. The VLAN switching hub comprises a packet forwarding unit 201, a system device 401, a console I/O 95 and a packet switching unit 91 and is provided with MAC layer

interfaces 111 to 114 and PHY layer interfaces 311 to 314.

Fig. 2 shows the configuration of the packet forwarding unit 201. The packet forwarding unit 201 comprises a frame analyzer 402, a forwarding table memory 405, a table search unit 404 and a frame rewrite unit 406 having the characteristic function of the present invention in addition to a frame aggregation unit 403 and a frame transfer unit 407.

The present invention further uses a VLAN tag frame utilizing a tag format with TTL bit 2206 as shown in Fig. 15 and an IEEE802.3 network control frame 20001 as shown in Fig. 16 utilizing a network control tag format 2010 as shown in Fig. 17.

As an embodiment of the present invention, the frame transfer taking advantage of the IEEE802.3 network control frame 20001 as shown in Fig. 16 using a tag TTL check unit 503 in the frame analyzer 402 of the present invention as shown in Fig. 3, a tag calculation unit 715, an Multiple(N) tag insertion unit 710, an Multiple(N) tag remove unit 712 and an Multiple(N) tag replacement unit 713 in the frame rewrite unit 406 as shown in Fig. 7, a table memory 410 as shown in Fig. 6, the tag format 2206 as shown in Fig. 15 and the network control tag format 2010 as shown in Fig. 17 is described below.

The tag format 2206 as shown in Fig. 15 has a tag format configuration that stores TTL (frame survival

time) information to the lower 8-bit area in the 16-bit
area of the tag type 20061 according to the VLAN tag
format 2006 as shown in Fig. 14.

A TTL area 22065 has a value from 0 at the
minimum to 255 at the maximum. The value "255" is stored
at the packet transfer start position, but it is
decremented by one for every transfer by a node. The
value "0" means that the frame can be discarded.

The network control frame 20001 as shown in Fig.
16 stores the network control tag 2010 in the frame
transferred by the user in order for network control.

The network control tag 2010 is constituted
according to the format in Fig. 17. Tag types 20101-1
and 20101-2 store the type of the network control tag as
15-bit information. An end point bit 20102-1 shows the
end point of several tags stacked. A subtype 20104 is
used to show more detailed type of the tag type 20101. A
version 20105 shows the version information for the
specification of the network control frame 20001.

These 32 bits in total are treated as an initial
tag of the network control tag and followed by several
tags. One tag has the information for network control
and administration of 31 bits in total as network
control information 20106-1 and 20106-2 and an end point
bit 20102-2 showing the end point of the final tag is
added.

The VLAN switching hub 20 as shown in Fig. 1 is

provided with at most four ports of interfaces (IF) that enable transfer of frames including Ethernet frame with VLAN tag 1001 as shown in Fig. 13 and the tag 2206 having the format shown in Fig. 15.

The VLAN switching hub 20 is installed at the nodes 1 to 5 of the network as shown in Fig. 12 and serves for frame transfer processing.

Frame transfer from I/F:1 to I/F:2 at node 4 as shown in Fig. 12 is described below.

A frame input from I/F:1 of the VLAN switching hub 20 is, via PHY311 and MAC111, input as an input frame 4001 to the packet forwarding unit 201 as shown in Fig. 2.

In the packet forwarding unit 201, the input frame 4001 is sent to the frame type judgement unit 501 of the frame analyzer 402 in Fig. 3.

The frame type judgement unit 501 identifies the type of the input frame 4001 and sends the frame type information to the search key decision unit 504 and the header information of the input frame 4001 to the frame header analyzer 502.

The frame header analyzer 502 analyzes the header information and extracts the destination MAC address information 2001, source MAC address information 2002, VLAN tag information 2006 and Ethernet attribute information 2003 as shown in Fig. 13 from the header information.

Among the extracted header information, the VLAN tag information 2006 is sent to the tag TTL check unit 503, which is a characteristic component of the present invention, to check whether the value of the TTL area 22065 in Fig. 15 is "0" or not.

If the value of the TTL area 22065 is "0" as a result of the check, frame discard information 25003 is output and the instruction to discard the frame is sent to the frame header analyzer 502.

If the value of the TTL area 22065 is not "0", the frame discard information 25003 is not output and the frame discard instruction is not sent.

When the frame header analyzer 502 receives the instruction to discard the frame, it instructs the frame type judgement unit 501 not to output input frame information 5006 and executes the frame discarding for the input frame 4001.

When the frame discard instruction is not given, the frame header analyzer 502 outputs the frame header information 5003 and sends the header information to the search key decision unit 504.

The search key decision unit 504 decides the port used for frame transfer and the table search key to find the processing method for the frame from the frame type and the header information and sends table search key information 5005 to the table search unit 404 in Fig. 4.

The frame type judgement unit 501 outputs the

input frame 4001 as the input frame information 5006 in case any frame discard instruction is not given to the frame header analyzer 502.

In the table search unit 404 of Fig. 4, the table search key information 5005 and frame header information 5003 are input to a table read address decision unit 605.

The table read address decision unit 605 estimates and calculates the address where the same information as the table search key information 5005 is stored from its information, decides the table reference address and sends a table address 26002 to the forwarding table memory 405 of Fig. 5.

The forwarding table memory 405, using the information at the table address 26002, refers to the contents of the table memory 410 with a memory read circuit 411 and sends the referred information as table information 26003 to the table search unit 404 with a memory information output circuit 412.

According to the present invention, the table memory 410 comprises a memory table as shown in Fig. 6. It stores the tag information at the first step and several pieces of tag information from the second step as well as the number of control steps required for control of several pieces of tag information and the control information. Thus, several pieces of tag information are sent to the table search unit 404 at a time as the table information 26003.

The table memory 410 as shown in Fig. 6 is described below. The table memory 410 administrates several pieces of tag information as described above. In this table, frames for insertion of the network control tag 2010 as shown in Fig. 16 are administrated and the information required for network control is sent and received.

The contents of the first entry in the table of Fig. 6 represent that, because the number of tag control steps is "4" for a frame with the source MAC address "00-00-0c-01-02-03", a four-step tag storing the operation information for network control is inserted.

Further, the contents of the final entry in the table show that the source MAC address is "00-00-0c-01-02-05" and the frame storing the maintenance information sends the frame as a transfer-to-CPU frame 9004 shown in Fig. 10 to a CPU 408 and receives the network control information because the output port information is "0".

For table search key information 5005 used in the two cases above, the former is the MAC source address: 00-00-0c-01-02-03 and the latter is the source MAC address 00-00-0c-01-02-05 and the tag information (Maintenance information). Thus, the network control tag 2010 is stored in the transfer frame so that the information required for network control is exchanged.

The table information 26003 sent from the forwarding table memory 405 to the table search unit 404

is input to an information comparison unit 606 and compared with the table search key information 5005 to see if they are the same.

If they are the same as a result of comparison, output port information of the frame is output to output port information 6004 and the information comparison unit 606 outputs tag information 27001 and tag control information 27002 and the table read address decision unit 605 sends the frame header information 5003 both to the frame rewrite unit 406.

If they are not the same, decision of the table read address is requested again to the table read address decision unit 605 and the table information 26003 is obtained from the forwarding table memory 405 until the information equal to the table search key information 5005 is obtained.

If the same information cannot be obtained even after checking the whole area of the forwarding table memory 405, information to the CPU is sent to the output port information 6004 and the frame is transferred to the CPU 408 as the transfer-to-CPU frame 9004 as shown in Fig. 10.

In the frame rewrite unit 406 as shown in Fig. 7, a frame header buffer 711 stores information of the frame header information 5003 and the variable length tag information 27001 and the tag control information 27002 are input to a tag controller 714.

The tag controller 714 sends the tag information 27001 and the control instruction to one of the following units: the Multiple(N) tag insertion unit 710, the Multiple(N) tag remove unit 712, the Multiple(N) tag replacement unit 713 and the tag calculation unit 715 corresponding to the contents of the tag control information 27002.

Here, the Multiple(N) tag insertion unit 710, the Multiple(N) tag remove unit 712, the Multiple(N) tag replacement unit 713 and the tag calculation unit 715 in Fig. 7 are described below.

The Multiple(N) tag insertion unit 710 takes out the information from the tag information 27001 for the number of steps instructed by the tag controller 714 and inserts several tags to the header information stored in the frame header buffer 711.

Similarly, the Multiple(N) tag remove unit 712 and the Multiple(N) tag replacement unit 713 take out the information from the tag information 27001 for the number of steps instructed by the tag controller 714 and removes and replaces several tags of the header information stored in the frame header buffer 711.

As shown in Fig. 8, the tag control information 27002 is sent to a tag operation controller 753 and the tag information 27001 is sent to a tag buffer 754 in the tag calculation unit 715.

The tag operation controller 753 sends a control

instruction to an X-OR operation unit 751 and a TTL

addition/subtraction unit 752 corresponding to the

contents of the tag control information 27002.

When the control instruction is sent, the X-OR

operation unit 751 executes X-OR operation and the TTL

addition/subtraction unit 752 executes addition or

subtraction for a part of the tag buffer 754. The

operation result is sent as the tag operation processing

result 27016 to the frame header buffer in Fig. 7.

The TTL addition/subtraction unit 752 decrements

the contents by one every time the frame transfer is

executed for the TTL area 22065 shown in Fig. 15.

Thus, even when a route control that circulates

in the network for a long time is executed, the frame is

surely discarded after transfer for 255 times in the

VLAN switching hub 20 according to the functions of the

TTL addition/subtraction unit 752 and the above tag TTL

check unit 503 as shown in Fig. 3.

At the Multiple(N) tag insertion unit 710, the

Multiple(N) tag remove unit 712, the Multiple(N) tag

replacement unit 713 and the tag calculation unit 715 in

Fig. 7, the changed frame header buffer 711 is, after

processing completion, rewritten and sent as frame

header information 27004 to the frame aggregation unit

403 as shown in Fig. 9.

At the frame aggregation unit 403 in Fig. 9,

input frame information 5006 is input from the frame

analyzer 402 in Fig. 3 to a frame decomposition unit 801.

At the frame decomposition unit 801, the input frame information 5006 is decomposed to the header information and the payload information and the respective information is output to an input frame header information buffer 802 and an input frame payload information buffer 803. If the frame header information 27004 is sent after frame rewriting, however, the input frame header information buffer 802 replaces the header information with the frame header information 27004 after frame rewriting.

After that, the input frame header information buffer 802 and the input frame payload information buffer 803 output the data to a frame buffer 804. Thus, the header and the payload section are synthesized and output frame information 8005 is sent to the frame transfer unit 407 in Fig. 10.

The frame transfer unit 407 in Fig. 10 stores the output frame information 8005 sent from the frame aggregation unit 403 to an output frame buffer 902.

After that, a frame transfer indication unit 901 takes out the frame from the output frame buffer 902 and outputs the output frame 4009 to the port obtained from the output port information 6004 sent from the table search unit 404 in Fig. 4

In this embodiment, the output port information stores the information of I/F:2 and the frame is output

from the I/F:2 for the output frame 4009. If the output
port information 6004 is addressed to the CPU, the frame
is output to the transfer-to-CPU frame 9004.

In addition, the frame transfer indication unit
901 also processes the frame sending from the CPU 408.
For the frame sending from the CPU 408, a network
control program 913 of the CPU 408 as shown in Fig. 11
creates a frame and sends output port information 9005
for CPU transfer frame and CPU transfer frame
information 9006 to a CPU transfer frame controller 903
in Fig. 10.

After that, the CPU transfer frame controller 903
sends the frame information and the output port
information and instructs the frame transfer indication
unit 901 to send the frame.

The CPU 408 as shown in Fig. 11 is described
below. In the CPU 408, the network control program 913
for network control is operating and a forwarding table
control program 911 that processes the frame
transmission from the CPU as described above and
operates the information from the forwarding table
memory 405 and the table memory 410 as shown in Figs. 5
and 6 described above is operating.

The forwarding table control program 911 outputs,
according to the instruction from the network control
program 913, the information required for network
control including the table write information 24015 and

the table write address 24014 to the table memory 410

and thus controls sending and receiving of the

information required for network control. In addition, a

device control program 912 also runs on the CPU 408. The

5   device control program 912 outputs device control

information 9101, which is the information for device

control, according to the network control program 913.

Though the present invention has been described

with showing preferred embodiments and examples so far,

10   it is not limited to the above embodiments and the

examples. It can be embodied with various changes

without departing from the technological spirit of the

invention.

As described above, excellent effects as shown

15   below can be obtained by the present invention.

By realizing the function to insert the network

control tag storing the network control information into

the user frame, transmission of the network control

information becomes available even while the user is

20   using the network.

By storing the network control frame in tags, the

network control information can be sent in the minimum

size without being restricted by the minimum frame size

of 64 bytes according to Ethernet standard and thereby

25   suppression of the network bandwidth can be minimized.

With a circuit to process several tags and a

table administration method to administrate several tags,

it becomes possible to give several tags in frame

transfer, which enables sending of a large amount of

information such as network control information as tags.

With a TTL field provided in the tag to be

5   processed at the date link layer, it becomes possible,

through subtraction and checking by a TTL check circuit

and a tag operation circuit, to discard the frame during

VLAN packet transfer at the data link layer even when a

looped network is formed. Thus, occupation of the

10   network by looped packets or oppression of the packet

memory in the system is prevented, which results in

prevention of unstable network.

Although the invention has been illustrated and

described with respect to exemplary embodiment thereof,

15   it should be understood by those skilled in the art that

the foregoing and various other changes, omissions and

additions may be made therein and thereto, without

departing from the spirit and scope of the present

invention. Therefore, the present invention should not

20   be understood as limited to the specific embodiment set

out above but to include all possible embodiments which

can be embodies within a scope encompassed and

equivalents thereof with respect to the feature set out

in the appended claims.